ascribed to them as food for the deep-sea forms; though not weighted, like the radiolarians, diatoms, &c., with silex, still they might in time fall from the table of the upper waters on, or rather down, to that of the hungry deep-dwelling forms. In the chapter on the relations of the Abysmal zone and the origin of its fauna, the author introduces the new classification of the ocean fauna, "Plankton," "Nekton," and "Benthos," and he is good enough to write that though "it will not be necessary to use these terms very frequently in this little book, it may be advisable for the reader to bear in mind that in any exhaustive treatise on the marine fauna such terms would be used and employed." We, however, only find in the index one reference to them, and that the one we have just quoted; nor in the following chapter, treating of the characters of the deep sea fauna, does the author employ them, though here their use might have assisted the meaning. Perhaps this Greek armour was found too cumbrous.

The last paragraph of this chapter we would have preferred omitted. We cannot see the relevancy of Moseley in comparing the deep sea fauna, even "as a whole," as in any way similar to the flora of the high mountains. If some of the deep-sea forms are dwarfed, this is surely the exception, and giants of almost all the groups are to be found among them; whereas what gigantic representatives of any group are to be found on the mountain tops?

The remaining four chapters treat of the Protozoa, Cœlentera, Echinoderma, Vermes, Mollusca, Arthropoda, and Fish of the deep sea. They open with a regret that "although thousands of species of animals have been described in the volumes that have been devoted to deep-sea work, yet the number of the sub-kingdoms and classes remains the same," and conclude with a hope, in which we join, "that in the future there may be a new stimulus given to deep-sea research, and that the many unsolved problems may be again seriously studied and eventually solved."

A Treatise on Elementary Hydrostatics. By John Greaves, M.A. (Cambridge University Press, 1894.)

A BRIEF examination of this treatise is sufficient to allow us to form a favourable opinion of its contents. Nearly every proposition or description shows that the author is a thorough master of his subject, and, what is also of equal importance, can impart his knowledge to his readers in language both concise and fresh. The treatise is intended for those preparing for the first part of the Mathematical Tripos, and is different from other elementary works on the same subject in the following manner: In this Tripos examination one is now allowed to use the notation of the calculus, which for some students is a great boon, in that problems can be more easily solved, and in less time. We are thus presented in the text of this treatise not only with the usual proofs, but with alternative proofs when the use of the calculus is a distinct advantage. This alteration will be found an improvement. The definition of a fluid, from which are deduced the principles of the subject, is given as "a substance which will yield to any continued shearing stress, however small, or," in other words, "when a fluid is in equilibrium, the stress across any plane in it is entirely normal to that plane."

Among other useful additions to the subject may be mentioned propositions relating to a heterogeneous fluid in equilibrium under any system of forces, and some cases of simple motion, the latter of which may be left for a second reading. In chapter ix. the author deduces several well-known capillary phenomena from the experimental result that the energy of a material system depends to a great extent on the surfaces separating the different substances.

As the book is printed in clear type and contains neat diagrams, it will be sure to find favour with students.

LETTERS TO THE EDITOR.

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Sun-spots and Magnetic Disturbances.

The note in NATURE for February 22, 1894 (p. 397) concerning "Sun-spots and Magnetic Disturbances" illustrates most clearly the necessity for the adoption of a proper method in order to arrive at any conclusion respecting the relation between these phenomena. I must continue to insist, as I have done heretofore in the columns of NATURE and elsewhere, that the study of the periodicity of magnetic storms and auroras at intervals of about twenty-seven and one quarter days must precede that of the attendant solar conditions, otherwise no results will be obtained. For example, during the month of August 1893, to which the note above mentioned refers, sun-spots were so numerous that it would be utterly impossible to determine which group, if any, were in a location upon the sun capable of originating terrestrial magnetic effects. The proper way is to begin by disregarding solar conditions entirely, and arrange the magnetic storms or auroras of the period that it is desired to study, in series as they actually occurred at the twenty-seven and one quarter day interval. This being done, it is possible at a glance to determine what particular solar conditions reappear invariably when magnetic perturbations are recorded. In this way, and in this way alone, it becomes evident that whenever these magnetic effects appear, there is always a disturbed portion of the sun at the eastern limb and near the plane of the earth's orbit in that location. If the series of recurrences is sufficiently persistent to last through many solar rotations, it will be found that the disturbed area continues to have its effect in spite of considerable variations in the size of the spots, and that at times these effects may continue even when nothing but groups of faculæ remain, these being however, unusually bright and extensive in such a case. By following the history of such recurrences into the portion of the year in which any given disturbed portion of the sun is at a distance from the plane of the earth's orbit, when at the eastern limb, it is found that outbreaks of violent thunderstorms, which do not produce any disturbance of the magnetic needle, take the place of magnetic storms and auroras in the regular order of recurrence. There have been some phenomenal illustrations of this the past winter. Usually in this part of the United States a thunderstorm in winter is very rare, and, if it occurs, stands forth as a prominent event. Thus the thunderstorms of Christmas-day and night, in which buildings were struck by lightning in this State, were most exceptional, and, falling as they did upon the proper date to form the continuation of the strongest and most persistent series of thunderstorms and auroras that has been current the past year, were most striking. The above method of attacking the question is that which the writer has gradually developed for the purpose of systematic study. The relation having once been established by tracing the history faithfully and in detail, in the manner described, it is no longer absolutely essential to enter into the question of periodicity in order to secure evidence bearing upon the question. As soon as it is known what has to be looked for, it will only be necessary, when any very large increase of thunderstorms occurs, or any notable magnetic perturbations, as the case may be, to look at the proper part of the sun, and see whether it is the seat of disturbance. In this way it will be found that it is not the size of solar disturbances, but their activity at the critical date when they are in the proper location, that determines the terrestrial effects to which reference has been made. Thus it is a question throughout of the adoption of a proper method of investigation.

M. A. VEEDER.

Lyons, N.Y., March 12.

Dredging Expedition at Port Erin.

THE Liverpool Marine Biology Committee organised a dredging expedition from the Port Erin Biological Station at Easter. The party of a dozen naturalists included several members of the committee, Mr. I. C. Thompson, Mr. A. Leicester and Prof. Herdman, Prof. Weiss, Dr. Hurst, Mr.

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Gamble, and Mr. Hick from Owens College, Mr. W. I. Beaumont, and Mr. E. T. Browne. The steam trawler *Lady Loch* was chartered for two days, and the weather was perfect for work at sea. On the first day, the sea-bottom to the north of Port Erin, from Fleshwick to Contrary Head at Peel, was explored at twelve stations ranging from quarter of a mile to four miles from the coast, and from depths of ten to twenty fathoms. On the second day the steamer coasted along the west side of Calf Island and about four miles further to the west, dredging at nine stations from one to four miles from land, and at depths of nineteen to twenty-five fathoms. Two series of samples of the bottom deposits brought up in the dredge were preserved, the one set for more detailed examination in the laboratory, the other for transmission to the Jermyn Street Museum, where the Director-General of the Survey is forming a series illustrating the submarine deposits of our coasts. Besides the more ordinary gravels, sands, and muds, several peculiar deposits occurred, one of which was almost entirely composed of the shells of *Pectunculus glycimeris*, while another, which looked like a coarse sand, was seen to be formed of the broken spines of *Spatangus* and other Echinoderms. In some places the bottom for considerable distances is covered with *Melobesia* and *Lithothamnium*.

The greater part of the material obtained has still to be examined in detail, and will be treated of in future reports of the Liverpool Marine Biological Committee. Among the more noticeable forms obtained were:—The massive state of *Cliona celata*, *Sarcodictyon catenata*, the Echinoderms *Antedon rosaceus*, *Palmipes membranaceus*, *Luidea savignyi*, *Stichaster roseus*, *Echinocardium flavesceus*, *Cucumaria hyndmani*, *Thyone fusus*, and *T. raphanus*, *Cellaria fistulosa*, *Scalpellum*, *Tellina crassa*, and the Ascidians *Polycarpa comata*, *Engyra glutinans*, *Ascidia plebeia*, *Cynthia morus*, and a *Microcosmus* which seems an unknown form. Mr. Thompson and Mr. Browne worked townets both on the surface and also at the bottom attached to the dredge. Most of the crabs and other higher Crustacea were found to be spawning, and some of the Nudibranchs are spawning in the tanks at the Biological Station. A common anemone a few weeks ago produced about fifty young, which have now from twelve to sixteen tentacles.

Several of the dredging party are staying on to work at the Biological Station during a part or the whole of April, and another dredging expedition will be arranged by the committee at Whitsuntide. W. A. HERDMAN.

University College, Liverpool, March 26.

THE SCOPE OF PSYCHO-PHYSIOLOGY.

UNDER the title of psycho-physiology may be comprised those investigations in psychology which have explicit or tacit reference to the concomitant physiological processes, and which are characterised by the application of the experimental method. The boundaries of the subject are somewhat ill-defined, since it shades off into physiology on the one hand, and into introspective psychology on the other. I shall endeavour in this article to indicate the scope of such experimental investigations.

A chick, not many hours old, will peck with fair but not complete accuracy at any small object which catches its eye. Here we have a reflex and responsive action. A stimulus is received in a sense-organ; an impulse is carried centripetally along ingoing or afferent nerve-fibres; certain nerve-centres are thrown into activity; and an outgoing impulse is carried by efferent nerve-fibres to muscles which are thus thrown into co-ordinated activity. It is probable that, on the *first* occurrence of such an action, it is purely automatic and is performed in virtue of the possession, by the chick, of an inherited organic mechanism. It is accompanied by, but not guided by, consciousness. Such guidance, however, soon becomes evident. Throw to a chick two or three days old half a dozen caterpillars, some of them common "loopers," others yellow and black "cinnabars." In the absence of previous experience they will be equally seized. But the loopers will be swallowed, while the cinnabars will be dropped. Repeat the experiment next day. The loopers will be gobbled up at once. The cinnabars will remain almost, if not quite, untouched. An association has been formed between the sight and taste in the two cases. Consciousness is no longer merely an accompaniment of the action. It controls; enforcing the action in one case, inhibiting or restraining it in the other. It is probable that in the higher parts of the brain there are special centres, the physiological functioning of which is associated with this conscious control. Such activities of the chick, first those which are merely responsive and automatic, secondly those which are under conscious control, exemplify a wide range of activities both in animals and man.

Let us note the scope of the experimental work that they suggest. First, there is the nature and range of stimulation of the nerve-endings in the sense-organ. Secondly, there is the nature and rate of transmission of the impulses along the nerve-fibres afferent and efferent. Thirdly, there are the nature and localisation of the activities of the automatic centres, and the time occupied by their peculiar functioning. Fourthly, there is the physiological and psychological investigation of the nature and mode of origin of the consciousness which accompanies the movements of parts of the body during response. Fifthly, there are the conditions, psychological and physiological, of association. And sixthly, there is the mode of application of the control, and the localisation of specialised control centres, together with the estimation of the time-element in control.

All of these have been made the subject of careful and systematic inquiry by the method of experiment. In all cases such experimental investigation has led, if not to brilliant positive results, at all events to salutary acknowledgment of ignorance. Difficulties of interpretation abound. Nowhere are these difficulties greater than in the investigation of the physiology and psychology of colour-vision. Take a dozen individuals, and get them successively to indicate by means of the cross-fibres of the spectroscope how far they can see along the spectrum, first in the direction of the extreme red, then in the direction of the extreme violet. You will find marked differences. Perhaps one will show a quite unusual amount of variation, and you will probably find by other tests that he is colour-blind. Is this variation in the retina or in the visual centre of the brain? It is well known that the psycho-physiology of vision is still a matter under discussion. One of the difficulties seems to arise from the fact that what is physiologically complex is psychologically simple. Purple gives a simple psychological sensation; but it is due to a combination of physiological impulses, the coalescence or synthesis of which is, so to speak, below the threshold of consciousness. One cannot, or I cannot, psychologically analyse purple into its constituents, as one can analyse a musical chord. There is still a wide field for research in the psycho-physiology of sensation.

An important line of investigation, which has now been followed up for many years, deals, not with differences of kind or of quality in sensation, but with variations in intensity. Given a stimulus which excites sensation; now diminish it, on the one hand, until it ceases to excite sensation, and increase it, on the other hand, until it reaches a maximum of sensation. Then formulate the law which shall express the relation which increase of stimulation bears to the increase of sensation. The results of Weber's researches went to show that we must look not to the absolute, but to the relative increments of stimulus; and Fechner, extending and generalising Weber's results, formulated the law of the relations thus:—When the stimuli increase in geometrical progression, the sensations increase in arithmetical progression, or the sensation is proportional to the logarithm of its stimulus. Concerning this law, the exactitude and range of its applicability, and its philosophical *raison*

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